

We Claim:

1. A touchscreen liquid crystal display comprising:
a liquid crystal display including a viewing surface, a liquid crystal area containing liquid crystal located behind the viewing surface, a plurality of spaced apart elongate first electrodes located on a viewing surface side of the liquid crystal area and a plurality of spaced apart elongate second electrodes located on an opposite side of the liquid crystal area, the first and second electrodes overlapping to form an array of liquid crystal pixel elements, at least some of the first electrodes being displaceable towards the second electrodes in response to external pressure applied to the viewing surface; and
a control circuit connected to the first and second electrodes for controlling the operation of the liquid crystal display and including: (i) a driver circuit for driving the electrodes for selectively controlling a display state of the pixel elements; and (ii) a measurement circuit for detecting displacement of the at least some of the first electrodes in response to external pressure applied to the viewing surface.
2. The display of claim 1 wherein the measurement circuit is configured for measuring voltages across at least some of the pixel elements and detecting the displacement based on the measured voltages.
3. The display of claim 2 wherein the measurement circuit is configured for determining a location of the external pressure on the viewing surface based on the measured voltages.
4. The display of claim 3 wherein the measurement circuit is configured for determining a relative force of the external pressure on the viewing surface based on the measured voltages.
5. The display of claim 2 wherein the liquid crystal display includes at least one reference pixel element, the measurement circuit including a comparison circuit for comparing the measured voltages to a reference voltage measured from the at least one reference pixel element.

6. The display of claim 5 wherein the reference pixel element is located outside of a viewable area of the liquid crystal display a sufficient distance so as not to be substantially affected by external pressure applied to the viewing surface.

7. The display of claim 1 wherein the control circuit is configured for operating in a first mode and in a second mode, wherein in the first mode the measurement circuit measures an electrical characteristic of a subset of the pixel elements until the measured electrical characteristic indicates that external pressure has been applied to the viewing surface, after which the control circuit automatically operates in the second mode, wherein in the second mode the measurement circuit measures the electrical characteristic for a larger set of the pixel elements and determines the location of the external pressure based thereon.

8. The display of claim 1 wherein the electrical characteristic is a voltage measured across each of the measured pixel elements, the location of the external pressure being determined based on which measured pixel element voltage varies the greatest from a reference value.

9. The display of claim 1 wherein each of the first and second electrodes is a substantially transparent strip electrode, the first electrodes being arranged substantially parallel to each other, the second electrodes being arranged substantially parallel to each other and substantially orthogonal to the first electrodes for defining the array of pixel elements, each pixel element being associated with one of the first electrodes and one of the second electrodes, the measuring circuit including a sampling circuit for sampling a voltage across each of the pixel elements and a processing circuit for detecting the displacement and a location thereof based on the sampled voltages.

10. The display of claim 9 wherein a plurality of scan-able electrodes are included among at least one of the first electrodes and the second electrodes, each scan-able electrode being connected by an associated switch to the driver circuit, the sampling circuit

including a controller for individually controlling the switches, the controller being configured for opening the switch associated with a selected scan-able electrode and causing the voltage across the pixel elements associated with the selected scan-able electrode to be sampled when the switch associated therewith is open.

11. The display of claim 9 wherein the electrodes are Indium-Tin Oxide (ITO).

12. A method for using a liquid crystal display as a user input, the liquid crystal display having a plurality of first electrodes and a plurality of second electrodes located on opposite sides of a liquid crystal containing area, the first electrodes overlapping with the second electrodes defining an array of liquid crystal display pixel elements, each pixel element being associated with a unique location where an associated one of the first electrodes overlaps with an associated one of the second electrodes, at least some of the first electrodes being displaceable towards the second electrodes when pressure is applied to a viewing surface of the liquid crystal display, the method including:

(a) selectively driving the first and second electrodes to cause the pixel elements to display an image visible from a viewing side of the viewing surface;

(b) sampling voltages between the first and second electrodes; and

(c) determining based on the sampled voltages if any of the first electrodes have been displaced towards the second electrodes.

13. The method of claim 12 wherein the sampling step (b) includes sampling voltages between the first and second electrodes at at least some of the pixel element locations.

14. The method of claim 13 including sampling voltages at a sub-set of pixel element locations until a determination is made that a displacement of first electrodes has occurred and then sampling voltages at a larger set of pixel element locations and determining based on the sampled voltages from the larger set a relative location of the displacement.

15. The method of claim 14 wherein the sub-set of pixel element locations includes pixel element locations associated only with a single line in the array of pixel elements.

16. The method of claim 14 wherein the sub-set of pixel element locations includes a plurality of spaced apart groups of pixel element locations.

17. The method of claim 14 wherein sampling of the sub-set is carried out at a lower rate than sampling of the larger set.

18. The method of claim 14 wherein based on the measured voltages from the sub-set a general location of the displacement is determined, and the larger set is selected to include the general location.

19. The method of claim 13 including determining a relative location of the displacement and a relative magnitude of the force causing the displacement based on the measured voltages and translating the determined location and magnitude into at least one input value for an electronic device associated with the display.

20. The method of claim 13 including determining the center of deflection of the displaced first electrodes by determining, based on the measured voltages, a weighted average of the deflection at a plurality of the pixel locations and determining a centroid of the deflection based on the weighted average.